## Population Structure and Dynamics of the Lemon Shark, Negaprion Brevirostris, on a Local and Global Scale: Microsatellite and Mitochondrial DNA Analysis

Mary V Ashley
U of Illinois Chicago

*Abstract* Comprehensive field and laboratory investigations will be undertaken to determine the local mating system and geographic population structure of the lemon shark, Negaprion brevirostris, a large coastal shark and a tropical apex predator. The research objectives are to: 1) genetically characterize, for the first time, the mating system of a cartilaginous fish; 2) clarify the use of a tropical nursery ground by juvenile sharks and females in paturition; and 3) examine population structure at both a local and extensive geographic scale. The study site at Bimini is unique in that nearly the entire juvenile population in the lagoon can and will be sampled, and genetic analysis of these samples will in large part provide the data for the first two objectives. Specifically, the field component includes a five-year sampling program of which three years have been completed. The data from juveniles will be supplemented by genotyping adults sampled in and around Bimini. The genetic and field data together will provide estimates of the total population size of pups, their growth, survival and movements, the number of females using Bimini as a nursery ground, and the relative reproductive success of males and females within and across years. Finally, the data can document whether individual females are returning to the Bimini nursery areas to give birth and if so, the interbirth intervals for females and the number of males siring their young. The third objective of the study will allow placement of the detailed local genetic structure documented at Bimini within the framework of the species genetic structure as a whole. Population structure at larger geographic scales will be accomplished through sampling 20-30 lemon sharks at four other locations that represent multiple spatial scales and potential barriers to dispersal. These sites include 1) a second Bahamian site (Grand Bahama Island) approximately 100 km across the NW providence channel from Bimini; 2) a second known lemon shark nursery west of the Florida Keys (Marquesas) separated from Bimini by 350 km and the Florida current; 3) a distant Atlantic site off the east coast of Brazil approximately 5000 km from Bimini; and 4) samples from the Pacific coast of Mexico completely isolated from the Atlantic sites by the Isthmus of Panama. Two methods of genetic analysis, microsatellites and mitochodrial DNA (mtDNA), will be employed in this study. Microsatellites exhibit the levels of variability necessary for inferring parent/offspring and sibship relationships at Bimini, especially when supplemented by additional genetic information provided by the maternally inherited mtDNA. The use of unlinked genetic markers having different transmission genetics (mtDNA is maternally inherited and microsatellite loci exhibit Mendelian inheritance) will provide separate but complementary estimates of genetic variation within and among populations, provide estimates of population differentiation and migration rates between the five sites in our study, and distinguish putative differences in patterns of male and female mediated gene flow.

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## Mating Success and Skewed Sex-Ratios in Sessile Marine Invertebrates

Daniel A Brazeau
U of Florida

*Abstract* Fertilization success among sessile, marine invertebrates is a largely unknown variable bridging those factors which field ecologists can measure (fecundity, organism size, population abundance) and one often difficult to estimate (reproductive success). Using the Caribbean octocoral Baiareum asbestinum as a model animal, this project will examine temporal and spatial variation in reproductive success for male and female colonies. The research will test the specific prediction that female fertilization success is directly proportional to the nearby abundance male colonies. This information is crucial for understanding the abundance and growth of invertebrate populations in coral reef ecosystems and will provide important information for the successful restoration and management of coral reefs worldwide.

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## Local Population Dynamics of Temperate and Tropical Reef Fishes at Multiple Scales

Mark H Carr
U of Cal Santa Barbara

*Abstract* There is considerable debate regarding the major processes that determine population sizes of organisms inhabiting rocky and coral reefs. Most of these organisms have complex life cycles that include widely dispersive propagules and relatively sedentary juveniles and adults, such that the 'birth rate' at a particular reef is equivalent to the rate of settlement of propagules. The controversy focuses on the extent to which supply of propagules vs. post-settlement processes determine local population size and dynamics. To resolve this issue we must know whether, and how, the demographic rates that determine population size at a particular site (settlement, immigration, mortality, and emigration) change with population density (i.e., are the changes in these rates density-dependent). Answering this question is of more than academic interest because, first, it provides the basis for understanding how local population size is regulated naturally, which is essential for effective management of fisheries and other natural populations, and second, it has seldom been answered adequately for any organism. This collaborative research is designed to answer the question of what drives local population dynamics in a comprehensive manner for four species of marine fish inhabiting two very different environments: temperate and tropical reefs. This multi-species, multi-system approach will provide some generality which can perhaps be applied to other marine systems, including demersal and bottom fisheries. Using well-proven methods, the combined experimental and observational design of this study will examine the roles of larval supply, settlement, recruitment, immigration, emigration, competition, and especially predation and its mechanisms, in driving local population dynamics. Results of the field work will be incorporated into mathematical models of population dynamics to provide conceptual generality applicable to other similarly organized systems.

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**Ontogeny and Dynamics of Cnidarian-Algal Symbioses**

Mary Alice Coffroth
SUNY Buffalo

*Abstract* Symbioses between cnidarians and dinoflagellates in the genus Symbiodinium are widespread in the marine environment. Their importance to reef-building corals and reef nutrient cycles is well documented, but surprisingly little is known about the ontogency of the symbiosis and the demographics of zooxanthellae populations within their hosts. An understanding of these processes is essential to understanding the symbiosis. Physiologic adaptations to conditions such as temperature and light may in fact be mediated by the demographics of the algal symbionts. The objective of this research is to determine the ontogeny of the symbiosis in a gorgonian coral that produces a zooxanthellate planulae larvae. Dr. Coffroth will examine initial zooxanthellate infection in planulae larvae and characterized the population structure of the zooxanthellae in established symbioses in adult colonies. These data will determine whether the observed host-algal association are the result of selection (mediated by the host or alga), stochastic process or simply suitability of the host "habitat" to the alga. Understanding the population dynamics of zooxanthellae communities has important ramifications for studying the symbiosis and how the symbiosis responds to environmental changes. It is now recognized that zooxanthellae are a diverse group. If this diversity iswidespread among single host colonies or if the association is in a state of continual flux, then changes in functional and physiologic traits may reflect changes in the algal community structure. In this case it will be critical to examine each component of the symbiosis and consider the population dynamics and ecological responses of both the coral and the algae to understand and preserve reef ecosystems. The first step, however, is to quantify this diversity and address how this diversity is established.

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**Population and Community Dynamics of Corals: A Long Term Study**

Joseph H Connell
U of Cal Santa Barbara

*Abstract* The objectives of the present project are several: 1) To extend the detailed long-term monitoring of ecological communities of corals and algae on the Great Barrier Reef, Australia which has been carried on continuously over the past 30 years, the longest such study on any coral reef; 2) to expand the study to include sites on two nearby reefs, and additional

replicate sites on Heron Reef; 3) to analyze spatial patterns and dynamics of corals and algae at several scales, from centimeters to tens of meters, both during the course of colonization of patches (opened by disturbances) and after most of the surface has become crowded by many colonies. These analyses should reveal the long-term effects of interactions that may be crucial in determining how natural communities are structured; 4) to test with controlled field experiments some hypotheses about mechanisms: a) that produce the unique species composition of corals at the Inner Reef Flat site, b) that cause contrasting patterns of algae after disturbances, and c) that determine precisely how each colony affects its neighbors; 5) to build mathematical models and computer simulations of the dynamics of these populations and communities of corals and algae: a) to investigate the influence of past and present conditions on future changes, b) to characterize temporal and spatial dynamics, and c) to test hypotheses about the consequences of these dynamics to the community. The models will be also used to asses the degree to which community structure and dynamics may or may not be influenced by details of spatial relationships. The field methods will use the standard sampling techniques used over the past 30 years, to assure continuity in the long-term data base. The experimental methods, using coral transplanting and cages to exclude larger herbivores, have also been used before in this study and are well- established. Larval choice experiments and new recruit t ransplants have been carried out successfully by the co- investigators elsewhere on the Great Barrier Reef. The significance of this proposed research to the advancement of knowledge is that: 1) it deepens the general knowledge of how natural communities of corals and algae (the dominant sessile organisms on tropical and sub-tropical reefs), are assembled and structured in the face of changes in their environment over extended periods of time; 2) it reveals some of the mechanisms that link the environment with these community changes, and how both vary over short and long time periods and between small and larger spatial scales; and 3) it helps to predict the effect of environmental changes, including those caused by human activity, on these natural communities.

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**Coupling Biological and Physical Processes Responsible for Retention of Coral Reef Fish Larvae**

Robert K Cowen
University of Miami

*Abstract* It is widely appreciated that coral reef fish larvae are transported to reef habitats by ocean currents. However, little is known about the behaviors that larval fishes perform to ensure their return to adult habitats. This study will employ an interdisciplinary approach to examine how circulation patterns influence retention and recruitment. Specifically, three-dimensional surveys of larval fish distributions, periodic monitoring of recruitment and detailed measurements of the water flow regime will be conducted in the vicinity of an isolated island (Barbados). Larval fishes will be collected with MOCNESS net tows. Local flow and water column structure will be mapped with ADCP, CTD, current meters and satellite imagery. Data from these tows and instruments will provide a basis for understanding linkages between the intra- and interannual variability of local flow, as well as relationships to the frequency and duration of mesoscale events.

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**Microstructure in Modern Marine Stromatolites: A Geomicrobiological Investigation of Processes Forming Lithified Micritic Laminae**

Alan W Decho
U of SC Columbia

*Abstract* This project will determine the origin of microcrystalline carbonate in stromatolites: is it precipitation resulting from bacterial metabolic activity, or physical trapping of resuspended particles? Crusting and “soft” mats from Exuma Cays, Bahamas, will be compared, with experimental intervention to encourage or inhibit lithification. Analyses will include structure and mineralogy of grains, structure of microbe community, mat physiology, and biogeochemistry of stable isotopes and extracellular secretions.

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**Ribosomal DNA Sequences in Marine Yeasts: A Model for Identification and Quantification of Marine Eukaryotes**

Jack W Fell
U of Miami

*Abstract* Using molecular techniques for rapid and accurate determination of community structure, this research will determine fungal biodiversity and population biomass of two distinctly different groups of micro-fungi: the basidiomycetous yeasts and the oomycetous genus Halophythophora. Both groups have important roles in detrital based food webs. The research program will include laboratory and field studies. Laboratory studies will complete the data bank of know species as abasis for determining community structure in the field. New procedures will be developed with preliminary emphasis on quantitative PCR (QPCR) using laser detected infrared labeled primers. Field research will center on reef and mangrove habitats. Using a combination of classical microbial techniques and molecular methods, the community structure and relative abundance of known and unknown culturable fungi species will be determined. The identity of these species will be ascertained by automated DNA sequence analysis and nucleotide alignment with the data bank. Species-specific regions will be located and primers developed to test the accuracy and sensitivity of PCR techniques in estimating community structure. Through the use of PCR and QPCR, the occurrence of unculturable species and population densities will be estimated. The techniques developed in this research can be applied to population analyses of other micro- or macro-eukaryote communities.

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**Local Population Dynamics of Temperate and Tropical Reef Fishes at Multiple Scales**

Graham E Forrester
U of Cal Los Angeles

*Abstract* There is considerable debate regarding the major processes that determine population sizes of organisms inhabiting rocky and coral reefs. Most of these organisms have complex life cycles that include widely dispersive propagules and relatively sedentary juveniles and adults, such that the ‘birth rate‘ at a particular reef is equivalent to the rate of settlement of propagules. The controversy focuses on the extent to which supply of propagules vs. post-settlement processes determine local population size and dynamics. To resolve this issue we must know whether, and how, the demographic rates that determine population size at a particular site (settlement, immigration, mortality, and emigration) change with population density (i.e., are the changes in these rates density-dependent). Answering this question is of more than academic interest because, first, it provides the basis for understanding how local population size is regulated naturally, which is essential for effective management of fisheries and other natural populations, and second, it has seldom been answered adequately for any organism. This collaborative research is designed to answer the question of what drives local population dynamics in a comprehensive manner for four species of marine fish inhabiting two very different environments: temperate and tropical reefs. This multi-species, multi-system approach will provide some generality which can perhaps be applied to other marine systems, including demersal and bottom fisheries. Using well-proven methods, the combined experimental and observational design of this study will examine the roles of larval supply, settlement, recruitment, immigration, emigration, competition, and especially predation and its mechanisms, in driving local population dynamics. Results of the field work will be incorporated into mathematical models of population dynamics to provide conceptual generality applicable to other similarly organized systems.

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**El Nino Impacted Coral Reefs in the Tropical Eastern Pacific: Secondary Disturbances, Recovery and Effects on Community Diversity and Reef Growth**

Peter W Glynn
U of Miami Sch Mar&Atmos

*Abstract* This project will long term study that has focused on ecological disturbances, causes, and the responses of eastern Pacific reef coral populations and reef communities during and following the severe and historically unprecedented 1982 1983 El Nino / Southrn Oscillation (ENSO) event. This study involves strong international collaboration with host country research teams working at several field sites in Costa Rica, Panama, and the Galapagos Islands (Ecuador), all areas that

were severely affected during the 1982 1983 ENSO disturbance. This study will continue with (a) monitoring the physical and biological conditions of eastern Pacific coral reefs initiated in the early to mid 1970s, (b) investigating the responses of different coral species to ENSO stressors (chiefly positive sea temperature anomalies) under controlled microcosm conditions, (c) studying coral reproductive ecology as it relates to recruitment success in field surveys, and (d) documenting coral community recovery or changes leading to alternate, non reef building communities. New research directions initiated in 1994 will be pursued, namely (e) an attempt to link coral bleaching/mortality with local and global scale sea surface temperature (SST) anomalies, and (f) modeling the size structure of coral populations and coral community dynamics based on mechanistic relationships between temperature, predation, coral growth, and survivorship derived from field monitoring and experimental results. In addition, (g) analyses of the molecular genetic structure of the different zooxanthella taxa found in eastern Pacific corals to assess the importance of zooxanthellae diversity in explaining the variability in patterns of coral bleaching, and (h) recovering coral populations, to assess their genetic structure and diversity in relationto population size and distance from source populations, will be investigated.

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**SGER: Measurements of Mesoscale Surface Currents in Support of Space-Time Translocation Patterns of Reef Fish**

Hans C Graber & Brian Haus
U of Miami

*Abstract* In this study we propose to augment the on-going biological and physical sampling phase of Cowen, Lwiza and Schultz (NSF OCE:-9521104) on the west coast of the oceanic island Barbados with surface current measurements using HF remote sensing technology. The measurements would provide maps of the evolution of the spatial and temporal variability in the regional circulation and the interactions of local flow with eddies generated at the retroflection of the North Brazil Current. The radar would operate in HF mode which would provide a spatial resolution of 1 km and would coincide with the shipboard biological/physical sampling scheme. The radar currents would provide crucial information on the dominant flow components such as tides, wind-driven, mean and residual circulation in this region. The HF radar measurements would be used to characterize the time space scales of the hydrographic signatures associated with eddies generated by the retroflection of the North Brazil Current. The addition of the remotely sensed currents to the shipboard sampling will provide direct measurements of the surface flow. Such information is crucial to interpreting the distribution of late-stage larvae that occupy this upper layer of the water column. Decomposing the current into components would be used to examine how the flow is influenced by such forcing agents as the wind. This is particularly valuable in the lee of the island where the wind stress will vary both spatially and temporally. Combining the surface and subsurface current measurements with the biological sampling would allow us to examine the linkages between reef fish larval distributions and island flow patterns. Specifically our study could assess the impact of offshore mesoscale events disturbing the local now regime and the fate of larval retention. Such knowledge is essential to understand the translocation patterns of coral reef fish larvae in an island wake environment.

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**Population Structure and Dynamics of the Lemon Shark, Negaprion Brevirostris on a Local and Global Scale: Microsatelite and Mitochondrial DNA Analysis**

Samuel H Gruber
U of Miami

*Abstract* Comprehensive field and laboratory investigations will be undertaken to determine the local mating system and geographic population structure of the lemon shark, Negaprion brevirostris, a large coastal shark and a tropical apex predator. The research objectives are to: 1) genetically characterize, for the first time, the mating system of a cartilaginous fish; 2) clarify the use of a tropical nursery ground by juvenile sharks and females in paturition; and 3) examine population structure at both a local and extensive geographic scale. The study site at Bimini is unique in that nearly the entire juvenile population in the lagoon can and will be sampled, and genetic analysis of these samples will in large part provide the data for the first two objectives. Specifically, the field component includes a five-year sampling program of which three years have been completed. The data from juveniles will be supplemented by genotyping adults sampled in and around Bimini. The genetic

and field data together will provide estimates of the total population size of pups, their growth, survival and movements, the number of females using Bimini as a nursery ground, and the relative reproductive success of males and females within and across years. Finally, the data can document whether individual females are returning to the Bimini nursery areas to give birth and if so, the interbirth intervals for females and the number of males siring their young. The third objective of the study will allow placement of the detailed local genetic structure documented at Bimini within the framework of the species genetic structure as a whole. Population structure at larger geographic scales will be accomplished through sampling 20-30 lemon sharks at four other locations that represent multiple spatial scales and potential barriers to dispersal. These sites include 1) a second Bahamian site (Grand Bahama Island) approximately 100 km across the NW providence channel from Bimini; 2) a second known lemon shark nursery west of the Florida Keys (Marquesas) separated from Bimini by 350 km and the Florida current; 3) a distant Atlantic site off the east coast of Brazil approximately 5000 km from Bimini; and 4) samples from the Pacific coast of Mexico completely isolated from the Atlantic sites by the Isthmus of Panama. Two methods of genetic analysis, microsatellites and mitochodrial DNA (mtDNA), will be employed in this study. Microsatellites exhibit the levels of variability necessary for inferring parent/offspring and sibship relationships at Bimini, especially when supplemented by additional genetic information provided by the maternally inherited mtDNA. The use of unlinked genetic markers having different transmission genetics (mtDNA is maternally inherited and microsatellite loci exhibit Mendelian inheritance) will provide separate but complementary estimates of genetic variation within and among populations, provide estimates of population differentiation and migration rates between the five sites in our study, and distinguish putative differences in patterns of male and female mediated gene flow.

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**Local Population Dynamics of Temperate and Tropical Reef Fishes at Multiple Scales**

Mark A Hixon
Oregon State University

*Abstract* There is considerable debate regarding the major processes that determine population sizes of organisms inhabiting rocky and coral reefs. Most of these organisms have complex life cycles that include widely dispersive propagules and relatively sedentary juveniles and adults, such that the "birth rate" at a particular reef is equivalent to the rate of settlement of propagules. The controversy focuses on the extent to which supply of propagules vs. post-settlement processes determine local population size and dynamics. To resolve this issue we must know whether, and how, the demographic rates that determine population size at a particular site (settlement, immigration, mortality, and emigration) change with population density (i.e., are the changes in these rates density-dependent). Answering this question is of more than academic interest because, first, it provides the basis for understanding how local population size is regulated naturally, which is essential for effective management of fisheries and other natural populations, and second, it has seldom been answered adequately for any organism. This collaborative research is designed to answer the question of what drives local population dynamics in a comprehensive manner for four species of marine fish inhabiting two very different environments: temperate and tropical reefs. This multi-species, multi-system approach will provide some generality which can perhaps be applied to other marine systems, including demersal and bottom fisheries. Using well-proven methods, the combined experimental and observational design of this study will examine the roles of larval supply, settlement, recruitment, immigration, emigration, competition, and especially predation and its mechanisms, in driving local population dynamics. Results of the field work will be incorporated into mathematical models of population dynamics to provide conceptual generality applicable to other similarly organized systems.

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**Biochemical Control of Larval Settlement and Recruitment of the Major Reef-Building Coral, Acropora Palmata**

Daniel E Morse, Peter T Raimondi & Aileen Morse
U of Cal Santa Barbara

*Abstract* The goal of the research is to determine whether molecular signals and mechanisms similar to those that control larval settlement, metamorphosis and recruitment of the Agariciid corals also regulate these centrally important processes in Acropora palmata, one of the most ecologically important, abundant and rapidly growing major reef-building corals of the Caribbean. This question is of major ecological significance because A. palmata is representative of the most specious genus of corals on Earth, and is representative of the ecologically dominant corals that reproduce by synchronous mass spawning to yield larvae that lack endosymbiotic algae (zooxanthellae). The corals in which signal-dependent induction of larval settlement and recruitment previously had been demonstrated (the Agariciid corals) reproduce by brooding and release of mature larvae that already contain endosymbiotic zooxanthellae, and these corals often play relatively minor ecological roles in the natural environment. Following up on recent research leads, the specific objectives of the proposed renewal are to test the following specific hypotheses: (1) That specific crustose coralline algae are required to induce larval settlement and metamorphosis of the mass-spawning A. palmata; (2) That chemosensory recognition mediates larval responsiveness to any such required substratum; (3) That the molecular inducer of settlement and metamorphosis recognized by A. palmata larvae is an algal (or microbial) cell- wall compound identical or closely similar to that which controls larval settlement, metamorphosis and recruitment of the sympatric Agariciids; (4) That larval recognition of this inducer molecule (purified and immobilized on a "larval flypaper") can be shown to be responsible, in part, for substratum-specific settlement, metamorphosis and recruitment of A. palmata in the natural environment; and (5) That species-specific differences in larval orientation at settlement reduce the potential for competition between Acropora palmata and Agaricia humilis.

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**Calcification by Hermatypic Corals: Regulation of the Calcium Pathway**

Erich M Mueller
Mote Marine Lab

*Abstract* Reef-building corals display two modes of calcification, that which occurs in the light and that taking place in the dark. Calcium carbonate deposition is greater in the light, a phenomenon attributed to the photosynthetic activity of algal endosymbionts (zooxanthellae). There is evidence that the two modes may differ in mechanism as well as quantitatively. In spite of numerous studies, the link between coral calcification and zooxanthellae photosynthesis remains unresolved. The significance of this link can be succinctly stated: the partnership of corals and their zooxanthellae is essentially responsible for the existence of the world's living (and most fossil) coral reefs. A major question is whether either of the calcium carbonate substrates, calcium and dissolved inorganic carbon dioxide, are limiting to calcification and, if so, under what conditions. The importance of calcium to living systems has led to a variety of well-conserved calcium regulatory mechanisms, however, very little coral research has examined such regulation. This strategy has a large base of information from research on other biomineralizing organisms and in many areas of cellular physiology. Such an approach, coupled with recent advances in coral culture, promises substantial progress in a research area that has made little during the past decade. This research project will focus on whether coral calcification is limited by calcium availability at the site of skeletogenesis (not in seawater) and how availability may be affected by symbiont photosynthetic activity. Using a combination of pharmacologic and kinetic approaches, the calcium pathway from seawater to skeleton will be compartmentally characterized. Calcium movement and regulation between compartments by membrane transport systems and messenger systems (i.e. cAMP, calmodulin ) will be of central interest. While this basic research question may be sufficient justification for this projec t, there are benefits of more practical value as well. Optimization of coral culture could have far reaching implications for coral reef conservation. Directly, it offers a means for propagation of corals to repair damaged reefs. Use of coral culture in the aquarium trade could indirectly help natural reefs by reducing the rapidly increasing wild harvest. Understanding the light-enhancement of coral calcification would allow manipulation of culture conditions to produce skeletons with consistent physical properties. Such skeletons would be of value for use in bone reconstruction where natural coral has been successfully employed.

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**RUI: Assessing the Chemical Defenses of Caribbean Sponges**

Joseph R Pawlik
U of NC Wilmington

*Abstract* Sponges are important components of benthic marine communities, particularly coral reefs. Organic extracts of their tissues have yielded a wealth of unusual chemical compounds that are not involved in primary metabolism, and have no known biological functions. The most commonly held theory is that these compounds are distasteful to potential predators, but they may also protect sponges from fouling or overgrowth. This project is a continuation of a research program designed to assess the defenses of Caribbean demosponges, a group whose taxonomy and chemistry is fairly well described, Because reef sponges are abundant and sessile, because they have evolved elaborate putative structural and chemical defenses, and are subject to grazing from generalist and specialist predators, they provide a useful group for testing fundamental hypotheses proposed by ecologists about plant defensive mechanisms.

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**Microstructure in Modern Marine Stromatolites: A Geomicrobiological Investigation of Processes Forming Lithified Miciritic Laminae**

R. Pamela Reid
U of Miami Sch Mar&Atmos

This project will determine the origin of microcrystalline carbonate in stromatolites: is it precipitation resulting from bacterial metabolic activity, or physical trapping of resuspended particles? Crusting and "soft" mats from Exuma Cays, Bahamas, will be compared, with experimental intervention to encourage or inhibit lithification. Analyses will include structure and mineralogy of grains, structure of microbe community, mat physiology, and biogeochemistry of stable isotopes and extracellular secretions.

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**Improvement of the Seawater System for the University of Guam Marine Laboratory**

Robert H Richmond & Steven S Amesbury
University of Guam

*Abstract* The University of Guam Marine Laboratory will expand and upgrade the seawater system in support of the growing demand for space to support research by both resident faculty and students as well as visiting investigators. Prior facilities improvements have included an upgrade of the seawater pumps, installation of a redundant system that allowed for pump maintenance and repairs without interruption of seawater flow and the addition of a back-up generator with an automatic transfer switch which has enabled the system to run continuously during periods of power outrage. The dependability of the present seawater system will enhance experimentation and increase use of the laboratory facilities for manipulative experiments under controlled conditions, and for longer term growth and physiological studies. With the recent completion of a visitors housing facility there is also an increasing demand for the use of the water tables by visiting researchers. In order to ensure the facility can meet the research needs of both resident and visiting scientists, the University of Guam Marine Laboratory will expand and upgrade the present facilities. The specific improvements include the seawater intake, expansion of the outdoor enclosed space, addition of mores eawater tables and tanks, and addition of a back-up well to allow continuous seawater availability during tropical storms and typhoons. The University of Guam Marine Laboratory supports the research of eight full-time faculty, numerous graduate and undergraduate students, as well as visiting investigators. The research demands on the facility have increased due to the addition of new faculty at the laboratory, the recent establishment of collaborative programs between the Marine Laboratory and the University of Hawaii and the University of the Ryukyus(Okinawa, Japan), and the awareness of the Marine Laboratory as a resource for coral reef research by over 550 scientists who attended the 7th International Coral Reef Symposium on Guam in June 1992. The improvements to the seawater system will allow the support of the increasing number of visiting scientists that wish to conduct research at the laboratory, which will in turn enhance the research environment.

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**RUI: Experimental Studies on Multi-Species Zooxanthella Communities and Coral Bleaching**

Robert G Rowan
University of Guam

*Abstract* Reef-building corals are obligate associations of heterotrophic animals and phototrophic dinoflagellate endosymbionts (zooxanthellae). Scientists have become interested in a conspicuous stress response — coral bleaching — that involves the 'breakdown' of this symbiosis, occasionally followed by ecologically devastating coral mortality. Interest in coral bleaching is motivated by the belief that these events are increasing world-wide, and by their potential value as a sensitive bioindicator of environmental change. However, large gaps in our understanding of both the ecology and causes of coral bleaching remain. These gaps frustrate attempts to relate coral bleaching to environmental issues. Recently completed studies on the Caribbean's dominant and most studied corals, Montastraea annularis and M. faveolata, revealed a fundamental misunderstanding that relates directly to coral bleaching. Contrary to the earlier, widely accepted belief that corals harbor only one symbiont, these corals host dynamic communities of three taxa of zooxanthellae that are primarily organized by gradients of ambient irradiance. This phenomenon explained a longstanding issue in coral bleaching ecology — an otherwise bewildering variation, both among and within coral colonies — in simple terms. Because it upsets a basic premise on which corals have been studied for decades, this discovery also opens up new and unexpected opportunities for experimental research. This project will analyze the environmental biology of Montastraea spp. in the explicit contexts of multi-species zooxanthella communities and environmental stress. Previous studies of these communities imply parallels with much better studied communities of terrestrial plants.

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**On the Abundance, Dynamics and Regulation of Damselfish Populations**

Russell J Schmitt & Sally J Holbrook
U of Cal Santa Barbara

*Abstract* The aim of the work is to understand the dynamics and regulation of structured, open populations, which typify most marine reef fishes and invertebrates. While there is broad agreement among ecologists that attributes of populations are shared by more than an single process (e.g., availability of propagules, competition within and between life stages, competition with other species, predation), there remains considerable disagreement regarding their relative importance. There also is some confusion about what roles various processes have in producing dynamics; few empirical workers have distinguished between processes that regulate populations (i.e., bound fluctuations) as opposed to those that cause variation around the mean abundance. An enormous amount is known about the caused of fluctuations in abundance of reef organisms, but very little is known about what regulates their populations. This work will contribute in several key ways to understanding the general issue of dynamics and regulation. It is one of the first comprehensive, pluralistic evaluations of reef fishes that will distinguish effects of processes on regulation and on variation. Second, it will use for the first time operational definitions and analytical protocols for quantitative assessments of the relative importance of various processes. As such, the research could yield standard approaches and procedures to address relative importance. Third, the application of infrared video technology enables the exploration of little studied but crucial processes of settlement and early mortality.

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**Microstructure in Modern Marine Stromatolites: A Geomicrobiological Investigation of Processes Forming Lithified Micritic Laminae**

Pieter T Visscher
Univ of Connecticut

*Abstract* This project will determine the origin of microcrystalline carbonate in stromatolites: is it precipitation resulting from bacterial metabolic activity, or physical trapping of resuspended particles? Crusting and "soft" mats from Exuma Cays, Bahamas, will be compared, with experimental intervention to encourage or inhibit lithification. Analyses will include structure and mineralogy of grains, structure of microbe community, mat physiology, and biogeochemistry of stable isotopes and extracellular secretions.

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**SGER: Impact of Severe ENSO Events on Insular Endemic Shorefish Populations**

Gerard M Wellington
U of Houston

*Abstract* Recent meteorological predictions indicate that a severe El Nino/SouthernOscillation will develop during that latter part of 1997 and extend through 1998.This ENSO event is predicted to be comparable or more intense than the 1982/ 83event the strongest ENSO recorded in this century. This SGER study will gather baseline data for investigating the effects of this ENSO on recruitment and population dynamics of reef fish populations in the Galapagos Islands. Of particular interest is the effects of hybridization and introgression observed between invading mainland species and island endemics that resulted from the 1982/83 ENSO. Recent work has found evidence to indicate that extensive recruitment of the mainland damselfish species, Stegastes acapulcoensis in Galapagos occurred during 1982 83.Currently extant populations of S. acapulcoensis coexist in Galapagos alongside the island endemic, Stegastes arcilrons. Otolith analyses of adult fish indicate that the first cohort of these adults arrived in 1983. The population has subsequently grown, presumably from local recruitment. In addition, a significant proportion of hybrids have been detected by electrophoretic protein analyses. Dr. Wellington predicts that another invasion will occur in early to mid 1998. He add associates will document the distribution and intensity of recruitment of S. acapulcoensis in the Galapagos Archipelago. These data will provide invaluable information needed to predict potential effects of climate change on insular marine organisms.